Overview of T-BAGS Base Isolation Method for Building Foundation

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***Abstract* —Tension BAGS (T-BAGS) can reduce seismic effect and earlier restoration from an earthquake disaster. It is safe and secure in low-cost construction method. Two-layer of T-BAGS can reduce earthquake vibration by top and bottom bags sliding. This paper describes general conception of T-BAGS Base Isolation System for building foundation with specification of the T-BAGS and the construction process including its characteristics, effectiveness and model results. According our study, T-BAGS Base Isolation Method can reduce the earthquake vibration from 800 gal of input to approximate 250 gal as its response motion and also reduce the 80% cost of the existing method to introduce.**

***Keywords* —Base Isolation, Earthquake, Building Foundation, T-BAGS, Seismic Effects**

I. INTRODUCTION

Recently, earthquakes happen all around the world and it is difficult to know its scale, it will happen where and when in advance. For example, a 7.3 magnitude earthquake occurred in Nepal in May 2015. After that, a series of earthquakes including a magnitude of 7.0 struck in Kumamoto City in Kyushu Region, Japan in April 2016. Due to this earthquake, 49 people were killed and several people were injured. In here, numerous structures were damaged, and the resident evacuated from their home due to this disaster [(1)]. Recently, a 6.8 magnitude earthquake struck in central Myanmar in August 2016 and at least 185 ancient Buddhist pagodas were damaged in Bagan [(2)].

We have already registered our construction methods to Patent Office in Japan. Almost of our construction methods are related with base isolation of building and it includes the ability to reduce the earthquake effect. Now, we will explain one of our patented technologies, "T-BAGS Base Isolation Method" [(3)] using the sand bags as the base isolation device. We have already conducted 17 buildings construction projects by using this method in Japan, and this method has four benefit points which are low cost, safety, secure and friendly for the environment. Although, there are many seismic base isolation methods, most of them are expensive but T-BAGS is a low-cost method to install.

II. SPECIFICATIONS of T-BAGS

T-BAGS is composed of geotextiles, filled with sand and these are widely used in the reinforcement of soft ground as a foundation.

There is approximately 400mm length, 400mm width and 80mm height shown in the Fig. 1(a) and Fig.1 (b). Creep life of the bags material is 250 years under the foundation. These bags are laid out both under the building foundation and the floor. The bags are piled up as two layers shown in the Fig. 2, and it is more effective to put a sheet between two piled bags for isolation of buildings from earthquake energy.

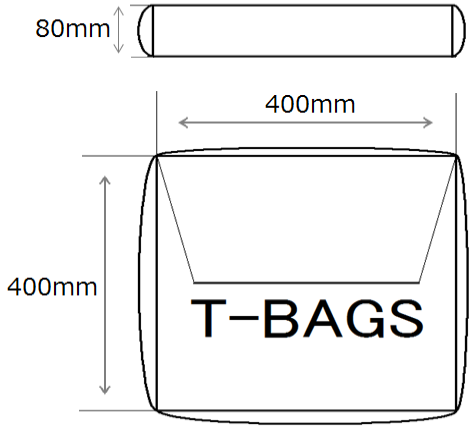

Fig. 1 (a) Specifications of T-BAGS

Fig. 1 (b) Photograph of T-BAGS

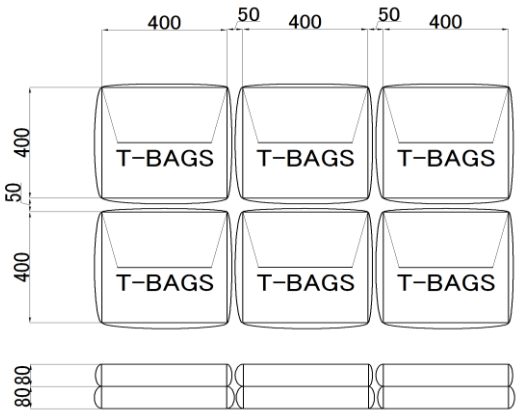

Fig. 2 Layout of T-BAGS two layers

III. GENERAL CONCEPTION OF BASE ISOLATION FOR BUILDING

A base isolation system is one of most powerful system for earthquake, which separates main structure of buildings from ground. An example of base isolation system is described in the following Fig. 3. In this system, isolator and net pole damper are included.

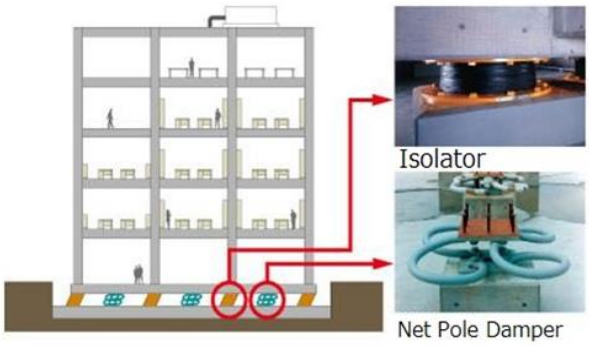

Fig. 3 Example of Base Isolation System for building

In our method, T-BAGS, is different from the mechanism of general system but the same effectiveness to reduce earthquake vibration. T-BAGS works as base isolation and its effective factors and characteristics are being now evaluated by Tsukuba Building Research Test Laboratory, Center for Better Living in Japan. In the present paper, we introduce outline of T-BAGS Base Isolation Method for buildings.

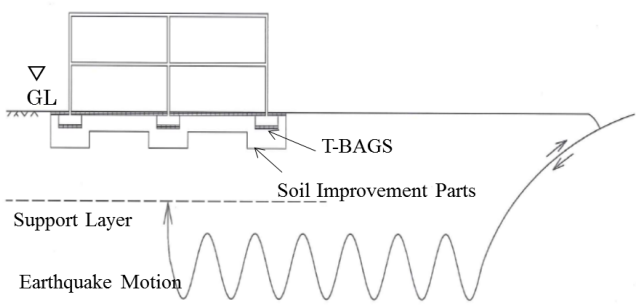

Fig. 4 Position of T-BAGS for building foundation

IV. CHARACTERISCTICS AND EFFECTIVE FACTOR OF T-BAGS BASE ISOLATION METHOD

Characteristics and effective factors of T-BAGS Base Isolation Method are described in the following.

(1) Effectiveness Against Earthquake

T-BAGS can suppress 300 gal ～ 800 gal of earthquake vibration to under 250 gal.

(2) Suitable for Soft Ground

By combination of T-BAGS Base Isolation Method and TNF method (New raft foundation construction method for soft ground) enables you to construct buildings on soft ground without pile.

(3) Low-cost Method for Installation

Installation cost of T-BAGS Base Isolation Method is one-fifth of rubber seismic isolation equipment in Japan.

(4) Free Maintenance

T-BAGS Based Isolation Method does not require regular maintenance because it has high durability.

(5) To Simplify Superstructure

In the case of buildings installed rubber seismic isolation system need stiffening member to be reinforced because the stress concentrate in the narrow area (point) vicinity of the seismic isolation system. On the other hand, T-BAGS Base Isolation Method supports buildings' loads by surface, thus it has no stress concentration and reduce the loads of buildings.

V. MODEL RESULTS

We have conducted a vibration test of T-BAGS Base Isolation device at Tsukuba Building Research Test Laboratory, Center for Better Living in Japan. The followings are the conditions of the test and the maximum response acceleration value as its results.

(1) CONDITION

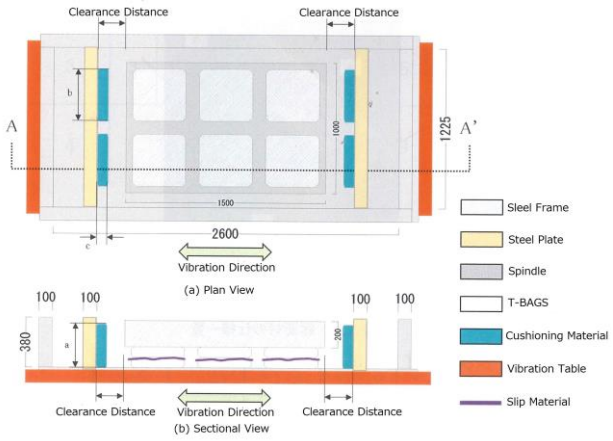

Fig. 5 Experiment image (Unit : mm)

The vertical load is set up 14.3 kN (1.46 ton×9.8 m/s^2). The friction coefficient is estimated to be 0.19 by experimental result. 105 mm space is set up between the T-BAGS and oscillating body, and rubber chips are charged as collision cushioning (W100mm×H400mm×D80mm) at the space. Input vibration sine-wave, acceleration and frequency are as shown in the following table

(2) RESULT

Table 1. Experimental Results

Experiment No.	Input Earthquake Motion		Max. Response Acceleration [m/s^2]	Residual Displacement [mm]
	Frequency [Hz]	Acceleration [m/s^2]		
1	3.0	4.0	2.00	-0.72
2	3.0	6.2	2.02	2.84
3	3.0	7.1	2.05	1.04
4	1.5	4.0	2.59	16.76
5	4.5	4.3	1.93	-13.08
6	4.5	9.2	2.06	-1.52
7	1.0	2.7	1.87	13.16
8	2.0	5.7	2.08	10.16

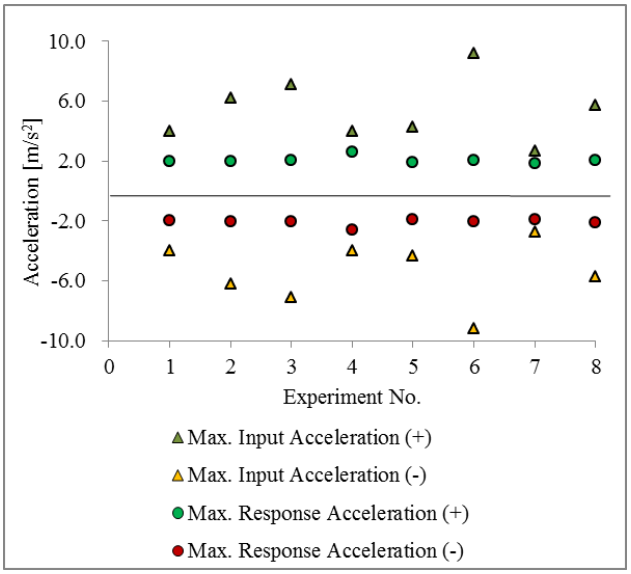

Fig. 6 Experimental results of acceleration

VI. CONSTRUCTION PROCESS OF T-BAGS BASE ISOLATION METHOD

The construction process of T-BAGS Base Isolation Method is expressed in the following.

(1) Fixing position of T-BAGS layout under the foundation and then
T-BAGS are laid at first layer as shown to the Fig. 7.

Fig. 7 First layer of T-BAGS are laying out

(2) Compaction of the first layer is as shown in the Fig. 8.

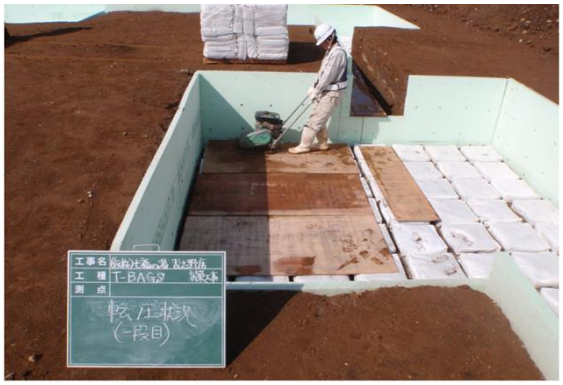

Fig. 8 Compaction situation of first layer

(3) The slip sheet is laid on the first layer. After that, T-BAGS of second layer is laid on the sheet.

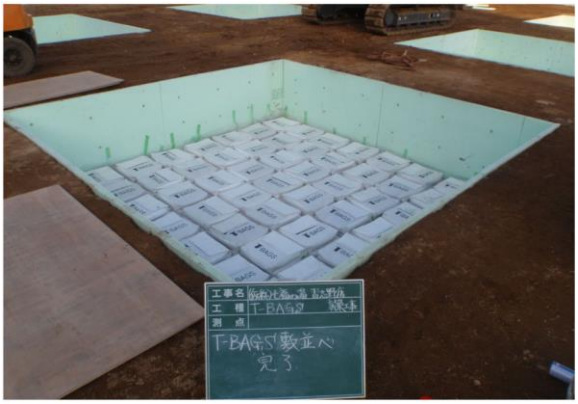

Fig. 9 Form of laid T-BAGS of second layer

(4) Then, compaction of the second layer is shown in the Fig. 10.

Fig. 10 Compaction situation of second layer

(5) Completed form of T-BAGS layers under foundation is shown in the Fig. 11.

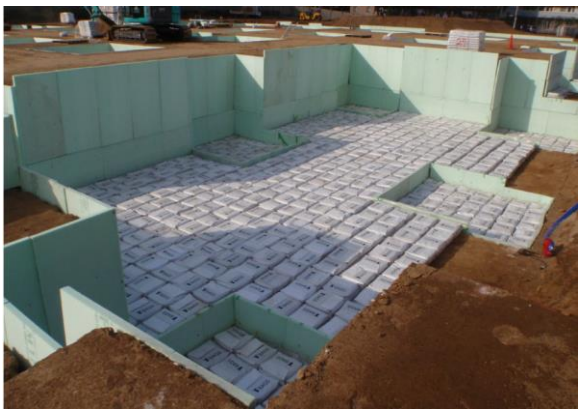

Fig. 11 Completed form of second layer

(6) Building foundation constructed on the T-BAGS layers are shown in the Fig.12.

Fig. 12 Completed form of concrete foundation

T-BAGS are laid also under the floor. The process is the same as that under building foundation and it describes briefly in the following.

(7) Laying T-BAGS of first layer under the floor is as follows.

Fig. 13 Laying form of first layer of T-BAGS under the floor

(8) Completed form of second T-BAGS layers of under the floor is shown in the Fig. 14.

Fig. 14 Laying form of second layer under the floor

(9) Completed Building is shown in Fig. 15.

Fig. 15 Completed buildings construction

VII. Conclusions

A method of T-BAGS base isolation for building foundation was described in overview of its specifications and construction process. This method is simple but it can reduce earthquake vibration of buildings. Hereafter, we will provide further information and experimental results of T-BAGS Base Isolation Method.

VI. References

[1] http://earthquake.usgs.gov/
[2] http://www.abc.net.au/news/
[3] 減震基礎構造体及びそれを用いた減震工法, Patent Number (JP) 5196059